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ABSTRACT

This ERIC Digest discusses concept mapping, a technique for representing the structure of information visually. Concept mapping can be used to brainstorm, design complex structures, communicate complex ideas, aid learning by explicitly integrating new and old knowledge, and assess understanding or diagnose misunderstanding. Visual representation has several advantages: (1) visual symbols are quickly and easily recognized; (2) minimum use of text makes it easy to scan for a word, phrase, or general idea; and (3) visual representation allows for development of a holistic understanding that words alone cannot convey. A wide range of computer software for concept mapping is now available for most of the popular computers used in education. Computer support for concept mapping facilitates ease of adaptation and manipulation, dynamic linking, conversion, communication, and storage. "Inspiration" is currently one of the most popular computer software programs for creating concept maps. (Contains 13 references.) (AEF)

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Concept Mapping: A Graphical System for Understanding the Relationship Between Concepts

by Eric Plotnick

This ERIC Digest is adapted from WWW documents prepared by Jan W.A. Lanzing, Department of Educational Instrumentation, Faculty of Educational Science and Technology, University of Twente, The Netherlands.

What is Concept Mapping?

In the 1960s, Joseph D. Novak (1993) at Cornell University began to study the *concept mapping* technique. His work was based on the theories of David Ausubel (1968), who stressed the importance of prior knowledge in being able to learn about new concepts. Novak concluded that "Meaningful learning involves the assimilation of new concepts and propositions into existing cognitive structures." A concept map is a graphical representation where nodes (points or vertices) represent concepts, and links (arcs or lines) represent the relationships between concepts. The concepts, and sometimes the links, are labeled on the concept map. The links between the concepts can be one-way, two-way, or non-directional. The concepts and the links may be categorized, and the concept map may show temporal or causal relationships between concepts.

Purpose of Concept Mapping

Concept mapping is a type of knowledge representation. Jonassen & Grabowski (1993, p. 433) state that structural knowledge may be seen as a separate type of knowledge. "Structural knowledge provides the conceptual basis for *why*. It describes how prior knowledge is interconnected. . . . Structural knowledge is most often depicted in terms of some sort of concept map that visually describes the relationships between ideas in a knowledge domain." Representing knowledge in the visual format of a concept map allows one to gain an overview of a domain of knowledge. Because the nodes contain only a keyword or a short sentence, more interpretation is required of the reader, but this may be positive. Concept mapping can be used for several purposes:

- To generate ideas (brainstorming);
- To design complex structures (long texts, hypermedia, large web sites);
- To communicate complex ideas;
- To aid learning by explicitly integrating new and old knowledge; and
- To assess understanding or diagnose misunderstanding.

Advantages of Concept Mapping

Visual representation has several advantages:

- Visual symbols are quickly and easily recognized;
- Minimum use of text makes it easy to scan for a word, phrase, or the general idea; and
- Visual representation allows for development of a holistic understanding that words alone cannot convey.

Applications of Concept Mapping

- **Creativity Tool**—Drawing a concept map can be compared to participating in a brainstorming session. As one puts ideas down on paper without criticism, the ideas become clearer and the mind becomes free to receive new ideas. These new ideas may be linked to ideas already on the paper, and they may also trigger new associations leading to new ideas.
- **Hypertext Design Tool**—As the World Wide Web becomes an increasingly powerful and ubiquitous medium for disseminating information, writers must move from writing text in linear fashion to creating hypertext documents with links to other documents. The structural correspondence between hypertext design and concept maps makes concept mapping a suitable tool for designing the conceptual structure of hypertext. The structure of both a hypertext document and a concept map can be seen as a directed graph or a knowledge graph (Conklin, 1987). A concept map placed on the Web in hypertext may also serve as a Web navigational tool if there are clickable areas on the concept map that take the user immediately to indicated parts of the hypertext document.

Designing hypertext is an activity with inherent problems. Botafogo, Rivlin & Schneiderman (1992) describe a dilemma faced by designers of hypertext authoring systems. In order to stimulate authors to write clearly structured hypertext (usually hierarchical), they have to decide when to force authors to reflect upon the structure of their work. Imposing a hierarchical structure from the beginning may result in too many restrictions for the author, while any effort to stimulate hierarchy afterwards is too late, and it may even be impossible for authors to restructure the jungle of nodes and relationships. Concept mapping may be a good intermediate step for authors to use to reflect upon their work when developing hypermedia.

- **Communication Tool**—A concept map produced by one person represents one possible way to structure information or ideas. This is something that can be shared with others. A concept map produced by a group of people represents the ideas of the group. In either case, concept mapping can be used as a communication tool for people to use to discuss concepts and the relationships between the concepts. They may try to agree on a common structure to use as a basis for further action.
- **Learning Tool**—Novak's original work with concept mapping dealt with learning. Constructivist learning theory argues that new knowledge should be integrated into existing structures in order to be remembered and receive meaning. Concept mapping stimulates this process by making it explicit and requiring the learner to pay attention to the relationship between concepts. Jonassen (1996) argues that students show some of their best thinking when they try to represent something graphically, and thinking is a necessary condition for learning. Experiments have shown that subjects using concept mapping outperform non-concept mappers in longer term retention tests (Novak, et al, 1983).

Concept mapping is also gaining inroads as a tool for problem-solving in education. Concept mapping may be used to enhance the problem-solving phases of generating alternative solutions and options. Since problem-solving in education is usually done in small groups, learning should also benefit from the communication enhancing properties of concept mapping.

• **Assessment Tool**—Concept maps can also be used as assessment tools. The research team around Joseph Novak at Cornell found that an important by-product of concept mapping is its ability to detect or illustrate the "misconceptions" learners may have as explanations of content matter. The conceptions students may have are often incomplete and deficient leading to misunderstanding of instruction. Concept maps drawn by students express their conceptions (or their misconceptions) and can help the instructor diagnose the misconceptions that make the instruction ineffective (Ross & Munby, 1991).

Advantages of Computer Support for Concept Mapping

Jonassen (1990) proposes that few of the computer tools used today for learning have been designed as learning tools. Usually educators use existing tools for teaching purposes. According to Jonassen, concept mapping computer tools belong to the rare category of computer tools that were designed specifically for learning. Some of the advantages of computer support for concept mapping include:

• **Ease of adaptation and manipulation**—Once you have a concept map on paper, try to fit in those forgotten concepts or the ideas you came up with overnight and you will know the advantages of computer assisted concept mapping. Anderson-Inman and Zeitz (1993) compare the use of the concept mapping program "Inspiration" (see below) with the paper-and-pencil approach and found that using this program "encourages revisions to the concept map because deletions, additions, and changes are accomplished quickly and easily."

• **Dynamic Linking**—Most computer assisted concept mapping tools allow the user to point and drag a concept or group of concepts to another place on the map and automatically update all the appropriate links.

• **Conversion**—Once a concept map is created using a computer, the program usually allows the user to convert the map to different electronic formats. These can be vector or bitmapped images, a text outline, or even a hypertext structure. These electronic formats can then be stored, sent, manipulated, used, printed, and deleted just like any computer file.

• **Communication**—Advantages of digital communication are speed, high fidelity, and reliability. Having a concept map in digital format allows the user to send concept maps as attached files with e-mail messages, or include them in World Wide Web pages. Digitizing enhances the possibilities of using concept maps as communication tools.

• **Storage**—Computer assisted concept mapping allows for digital storage of concept maps. Digital storage takes less space, makes retrieval easier, and is especially important if concept maps will be used on a large scale.

Computer Tools - An Example

• **Inspiration**—*Inspiration* <http://www.inspiration.com/> is currently one of the most popular computer software programs for creating concept maps. Organization of concepts, and brainstorming and mapping of ideas are mentioned in the User's Manual (Inspiration Software Inc., 1994) as primary functions of this program. The graphical capabilities of *Inspiration* make it an outstanding program for creating graphs for presentation purposes. Nodes may be shown in many different useful preset and user-defined shapes. Links may be straight or curved and may be labeled. Arrowheads may be placed on any side, and everything may be set to any color.

Anderson-Inman & Zeitz (1993) describe the classroom use of *Inspiration* and find that it encourages users to revise or change the maps (compared to maps drawn with paper and pencil). The graphical capabilities of *Inspiration* help users personalize concept maps. These capabilities also provide an incentive for users to manipulate concepts and revise conceptual relationships.

Summary

Concept mapping is a technique for representing the structure of information visually. There are several uses for concept mapping, such as idea generation, design support, communication enhancement, learning enhancement, and assessment. A wide range of computer software for concept mapping is now available for most of the popular computers used in education.

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